

A method for the three-dimensional and synchronous resolution of functional and spatial matters in architectural design.

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ABSTRACT:

The article discusses the issue of applied methods of teaching architectural design at Polish universities. The authors review the common methods based on conceptual drawings solving design problems in only two dimensions. After completing the floor plans' sketching process carried out in 2D way the 3D virtual models are made - seldom cardboard mock-ups - to illustrate the final spatial form of the designed object. At the Faculty of Architecture of Gdansk University of Technology the method of building an architectural concept is based on simultaneous analysis of spatial structure, functional connections and utility assumptions in three dimensions, by testing all the ideas in the mock-up structures first to find the adequate solutions for a particular context of the design. As the second stage of the design process the traditional methods of 2D design are implemented to conclude the architectural task. This process of building an architectural concept first in 3D mock-ups shapes students' spatial imagination - a desired ability in the architect's profession.

INTRODUCTION

The profession of an architect is a multidimensional profession requiring many skills in the field of art and technical sciences as well as knowledge in the history of culture, humanities, social and economic sciences. The task of schools of architectural is to prepare the student for the future profession of an architect. The education programs of architecture students in a diverse range handle these issues using different teaching methods [1].

There is no one leading line. Teachers experiment by searching for the optimal way to educate future architects. For example, at the University of Stuttgart, Germany, students experimented with unusual materials to create initial concepts such as eggs, balloons or shaving foam. This method of creating the concept became the beginning of such projects as the German pavilion at Expo'67 in Montreal or the roof over the Olympic stadium in Munich in 1972. In Poland, Oskar Hansen created the assumptions of the teaching method called the Open Form, based on the creative cooperation of the student group in a visual dialogue. Students in groups conducted visual activities through the cameras specially constructed for this purpose. This method was supposed to contribute to understanding the rules of the visual language and stimulate the imagination as well as intellectual abilities of students [1]. Experimental methods emphasizing the importance of selected aspects crucial in future architect activities, such as understanding and creating social behaviours, or rules of inter-branch cooperation are used in teaching architecture. However, in schools of architecture, the method of graphically building a preliminary concept in two dimensions by making hand sketches or using computer aided techniques is most common.

THE 2D METHOD OF GRAPHICAL BUILDING AN ARCHITECTURAL CONCEPT

In the teaching of architectural design the methods of graphically creating concepts as a two dimensional graphics are commonly used and then - using computer aided techniques - the final models of design objects are built in virtual space. Zychowska Maria notes that although the computers expedite the design work they do not replace the creative process of shaping architectural space. The drawing helps to develop spatial imagination [2, p. 137]. Bialkiewicz underlines the role of drawing in stimulating and developing space awareness [3, pp. 115,116]. This method is based on activities, applied practice and experience of well-known architects in the creation of initial assumptions of the design concept. " *All of Le Corbusier's design were preceded by a 'wave of drawings', which then served as the formal foundation – not necessarily as an exact and direct reproduction.*" [4, p. 129] for example the initial sketches of the Ronchamp Chapel became the keystones for the final project realized in France in 1955 [4, p.130] or the Composition

diagram by Toyo Ito provided the design guidelines for the Bruges Pavilion in Belgium completed in 2002 [5, p.158]. Rough conceptual sketches were revised and modified by building a number of fragmentary paper models. The models illustrating the final design solution adopted for the entire facility, its part or the detail were created only at the implementation stage. A variation of this method is a design based on a 'logo', which is a graphic symbol expressing the compositional concept of the designed object: *Capturing them is made possible thanks to their graphic notation – an indispensable element in communicating an architectural concept.*" [4, p. 26]. Graphical recording hasn't to be preceded by site or urban context analysis, it is a record of the creator's individual intellectual idea, characteristic for the concept being created.

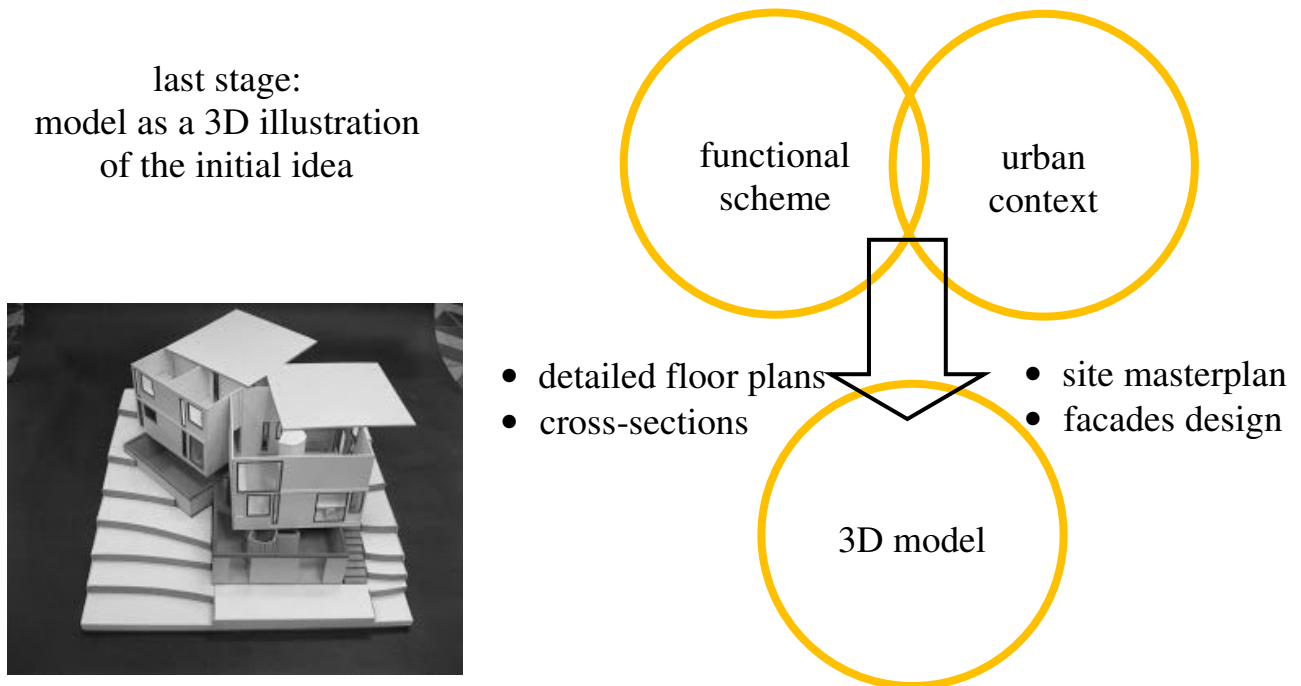


Figure 1. The scheme of the stages order in the traditional method of teaching architectural design: 3D mock-up as the last stage in the designing process

The adopted graphic ideogram is determinative in building the final spatial and functional concept of the object. Another variant of the method of graphically building the initial architectural concept is solving individual design problems after accomplishing the program-, urban- or historical- and landscape analysis. In practice, the basis for building an architectural concept are: a detailed functional program, including specified rooms with a specific surface and purpose, current law regulations, defining the size of the area that can be built up, the height of the designed object and the analysis of urban composition patterns illustrated on the map as well as the graphical ideogram if needed. All urban, function and usage analysis, environmental and landscaping connections are studied in 2D way applying freehand drawings or computer drawings. In the following stage of developing the semester project's concept the design is based on forming the functional segments of particular building floors in accordance with the assumptive functional program and the lawful regulations. After defining all floor plans, they 'are raised' by drawing characteristic cross-sections and by designing the shape and facades, which become the result of predefined projections of individual levels and elaborated function scheme. It is a two-dimensional design where students solve in following stages - the urban design, floor plans, cross-sections and facades with a minimal correction of design decisions taken in the primary stages of the project. On the basis of predefined plans and sections students create a model of the final designed architectural object in virtual space using computer techniques.

THE 3D METHOD OF BUILDING THE INITIAL ARCHITECTURAL CONCEPT OF DESIGN

Walter Gropius believed that *Traditional training involving only drawing is inadequate preparation. Drawing and painting are undoubtedly valuable means of self-expression, but paper, pencil, brush and watercolour are not useful in developing a spatial sense, indispensable in unhampered expression. Therefore, the student should first be introduced into three-dimensional experiments ... that is, spatial composition* [6, p.79]. He justified this by saying that *the task guiding such a training is not the improvement of professional skills, but the development of personality* [6, p. 80]. He also believed that *Architect's training should take place in a concentric rather than a segmental course; its essence is the complexity and gradually increasing accuracy of the approach, the increasing clarity of thoughts and the number of practical information on implementation* [6, p. 84]. To base on the principle defined by Gropius: *Three-dimensional*

imagery is the basic field of architecture [6, p. 84] and that studying of architecture *Must first teach looking, perceiving distance and entering human scale* [6, p. 84] at the Faculty of Architecture at Gdansk University of Technology in the Department of Housing and Public Buildings Architecture, a method of teaching architectural design was developed, consisting of simultaneous comprehensive analysis of spatial structure, functional connections and utility assumptions in three dimensions using cardboard mock-ups as a basic tools to recognize and understand the potential of reshaped space. Students use computer programs after defining a spatial and functional concept as a tool to illustrate their final design achievements. This method is used at the Faculty of Architecture at Gdansk University of Technology in architectural design classes conducted at the second level, at master degree studies. In the first stage of building the initial architectural concept, according to the theory of Francis D. K. Ching, contained in *Architecture. Form, Space and order* specifying that: *When space begins to be closed, surrounded, modelled and organized by the element of forms, architecture begins to exist* [7, p. 108] students will learn about the space that will be the subject of their architectural activities.

first stage:
Mater-model (mother-, matrix) as a
3D illustration of the context
(urban, historical, architectural,
functional)

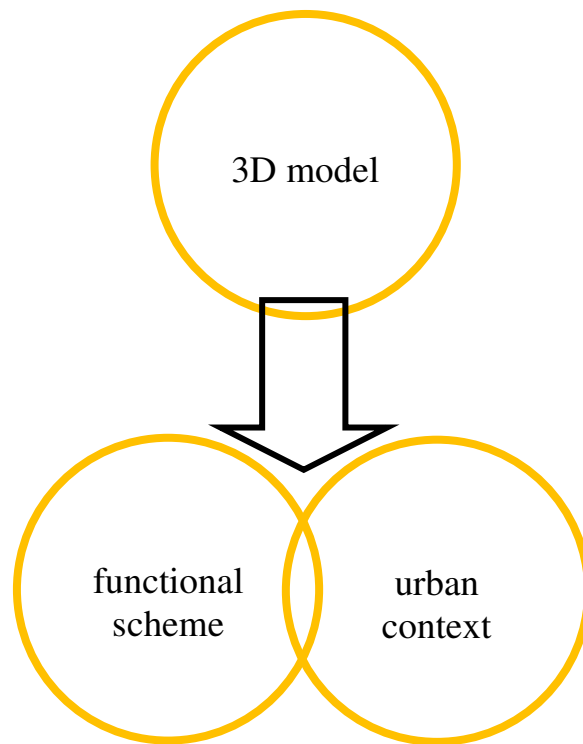
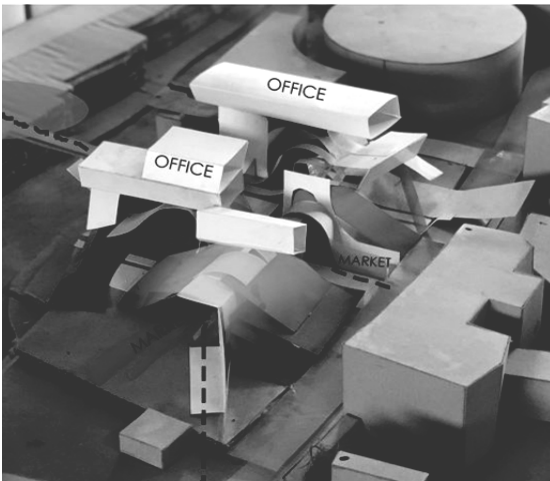


Figure 2. The scheme of the stages order in the synchronous method of teaching architectural design: 3D mock-up as the initial stage in the designing process.

The result of this study is to build a maters-model (matrix) of the existing spatial context in which they will design a particular object. Then, starting the process of creating the initial architectural concept, they base their approach on the principles defined by Żórawski, who says that architectural design is based on subsequent tasks and *these tasks will always consist in adding new parts to the already existing unity* [8, p.116]. At this stage of creating initial compositional assumptions, students look for the answer to the question: *what spatial form suits into the existing spatial and functional context of the selected location being the subject of the semester project?*, because according to Żórawski: *The form depends on the unity, in which it should appear* [8, p.116]. Searching the answer to this question students insert further spatial proposals into the previously made matrix mock-up. These are synthetic models illustrating the compositional idea as the reaction of the emotional experience of the particular space. Thereafter from the several proposals presented by the students one of the concepts - that best suits into the existing spatial and functional context - is chosen for further elaboration, while as Żórawski claims: *form depends on the relations of the parts with respect to the unity* [8, p. 116]. The selected mock-up contains compositional assumptions not only regarding the form of the designed object but also facades and urban context connections. Simultaneously students continue functional and usage analysis of the existing environment, searching for a reasonable response to the following question: *what usage would be the most appropriate for the designed object?* While making a decision of the target function of the designed object, which may become a public building, administration, hotel, etc., and following the records included in local development plans and current building law, students determine the number of storeys and their height dependent on the storeys destination purpose. A cross-section sketch is created to illustrate the number of possible usable levels contained in the adopted spatial concept considering the spatial law indicators. To advance the project development students have

to respond the question considering the most adequate location of the particular usage zones according the already evolved form of the building. They sketchily arrange defined groups of specific function rooms working on all levels controlling their relations simultaneously in 3D space. At this stage students implement blocks of staircases and lifts in optimal locations for the designed usage and functional as well as spatial connections. The spatial composition of the object's form recorded as the synthetic mock-up is of an overriding priority in all project activities stages. Since students define the general functional and communication scheme for the paper model body they proceed to detail particular solution in floor plans, cross-sections, facades and site plan development. At this stage students are allowed to support their design with the computer techniques for developing ultimate façades aesthetic expression, visualizations illustrating the designed spatial solution in existing context and the graphic design of the poster presentation.

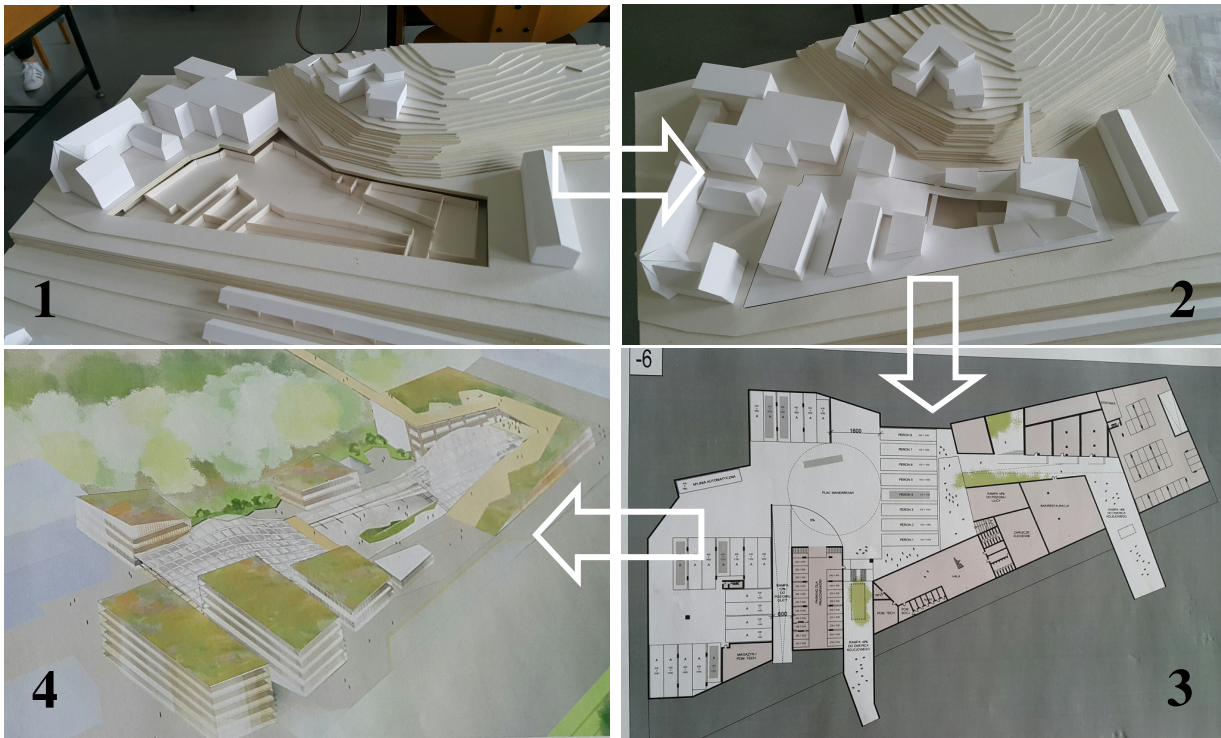


Figure 3. The results of the synchronous method of teaching architectural design: 1/. matrix model of the site and its context , 2/. mock-up as the initial stage of the project development, 3/. floor plans with details, 4/. axonometric presentation with suggested facades and landscape solutions.

CONCLUSIONS

All methods of the architectural design teaching mentioned in the paper above have their application with varying intensity in Polish architectural schools. All of teaching processes are conceived to prepare students for the future architect profession - a multi-faceted profession with high social responsibility [9]. In Poland - the profession of public trust. An architect in a great extend is responsible for the urban and rural spatial order so the task to teach a student to comprehend spatial issue and to learn and interiorize the principles of its formation has a large impact on the cities' future image. Students regularly are invited by the city authorities to present their visions for future development of particular city districts in urban or architectural competitions [10] where they are expected to use the 3D mock-ups methods. Therefore, learning how to design invoking Gropius: *should be based on comprehensive solving of architectural problems in space*, in other words building an initial spatial concept using the three-dimension creation. The final observation of the results in teaching architectural design by the implemented at the Gdansk University of Technology method of three-dimensional and synchronous resolution of functional and spatial matters supported by constructing cardboard mock-up brings to the conclusion, that this method teaches students that:

- a/. the spatial concept of the designed object depends on the existing spatial and functional context;
- b/. the spatial concept of the designed object complements the existing spatial context;
- c/. in architectural design the prime value is the spatial composition that suits the existing built-up context and increases the value of the designed place;
- d/. the functional solutions and relations between them may be properly designed in multi-variant options adapted to the accepted spatial form of the designed object;
- e/. there are functional dependencies in the space of a specific solid/object;

- f/. in designed space there are places that are most adequate for particular functions;
- g/. the location of vertical communication and installation units depends on the adopted spatial concept included in the mock-up;
- h/. the division of rooms in functional segments is multi-variant, ancillary to the adopted spatial concept embodied in the paper model;
- i/. it is necessary to find the interrelations between the floor plans and the facades concepts yet at the stage of a synthetic paper mock-up;
- j/. project development and elaboration based on the mock-ups building allows to grasp the proportions between the existing context and the planned spatial form;
- k/. building a 3D computer model in the initial design phase impedes students proper grasping the scale of the designed object in relation to the existing urban and architectural context;
- l/. it is easier to adapt designed spatial concept to the current law guidelines by using their correct interpretation in 3D context;
- m/. observing the 3D mock-up relations and construction it is more pertinently to select the adequate structural and installation systems to the adapted spatial form of designed object.

BIBLIOGRAPHY

- [1] Kędziorek A., Springer F., Oskar Hansen „*Opening Modernism. On Open Form Architecture. Art. And Didactics*” Museum of Modern Art. Warsaw. (2014). ISBN; 9788364177057;
- [2] Żychowska, M., Bauhaus – didactic experiments and their legacy, *Global Journal of Engineering Education*, vol. 21/2, (2019);
- [3] Białkiewicz, A., Propaedeutics of teaching drawing to architects, *Global Journal of Engineering Education*, vol. 21/2, (2019)
- [4] Krenz, J., *IDEOGRAM: from Idea to Architectural Form*, Universidade da Beira Interior, Portugal, (2014) ISBN: 978-989-654-146-0;
- [5] Ito, T., Yamamoto, R., Buntrock, D., Igarashi, T., *Toyo Ito*, Phaidon Press Limited, London, (2009), ISBN: 978 0 714845050
- [6] Gropius, W., *Scope of total architecture*, Collier Books; 1st THUS edition, (1962);
- [7] Ching, F.D.K., *Architecture, Form, Space and order*, Litton Educational Publishing. New York, (1979);
- [8] Żórawski, J., *Theory of build of architectural form*”. Wydawnictwo Politechniki Krakowskiej, Kraków, (2017) ISBN/ISSN: 978-83-7242-917-9;
- [9] Piątkowska, K., Moving Towards Competence in Teaching Architecture: The Relationship of Research and Design in Academia, *Procedia Engineering* (2016), Elsevier Limited, Oxford, UK, DOI: 10.1016/j.proeng.2016.08.613;
- [10] Piątkowska, K., Konkursy studenckie jako narzędzie w określaniu potencjału rewitalizacyjnego miejskich terenów zdegradowanych, *Urbanistyczne aspekty transformacji miast*, red. P. Lorens, KPZK PAN, tom CXCI, Warszawa, (2018), 208-220.